

# Collective motion of spherical particles induced by horizontal vibration

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The study measures experimentally the kinetic energy of  $N$  spherical particles moving on a horizontal plane. The plane is bounded by rectangular wall and shaken horizontally. A CCD camera above the system is used to record the motion of every particle so that the kinetic energy of the system can be analyzed by tracking the trajectory of each particle. We find that the motions of the spherical particles change from pure rolling to sliding at a certain filling fraction and the change of motion is accompanied by the abrupt change of the kinetic energy. We determine the critical value of the filling fraction and find it is a linear decreasing function of the driven amplitude. By considering the conditions for all particles moving collectively in resonance with the external drive, we propose a model that can well explain the linear relation between the critical filling fraction and the amplitude.